PRICE $1.00

HEATH COMPANY · BENTON HARBOR, MICHIGAN

HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT®

ELECTRONIC SWITCH

MODEL ID-22

RESISTOR AND CAPACITOR COLOR CODES

RESISTORS

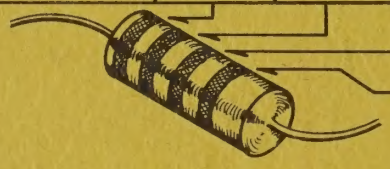
The colored bands around the body of a color coded resistor represent its value in ohms. These colored bands are grouped toward one end of the resistor body. Starting with this end of the resistor, the first band represents the first digit of the resistance value; the second band represents the second digit; the third band represents the number by which the first two digits are multiplied. A fourth band of gold or silver represents a tolerance of ±5% or ±10% respectively. The absence of a fourth band indicates a tolerance of ±20%.

The physical size of a composition resistor is related to its wattage rating. Size increases progressively as the wattage rating is increased. The diameters of 1/2 watt, 1 watt and 2 watt resistors are approximately 1/8", 1/4" and 5/16", respectively.

The color code chart and examples which follow provide the information required to identify color coded resistors.

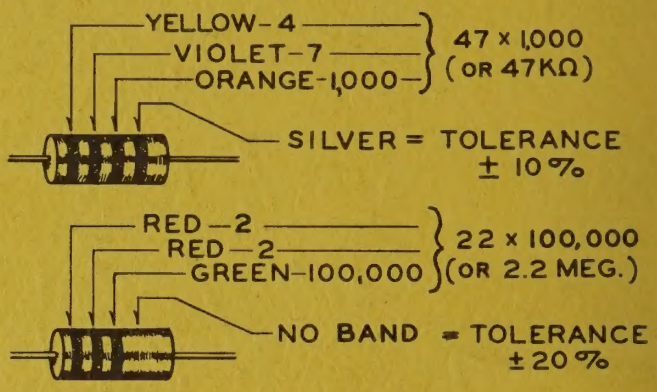
CODE

COLOR	1ST DIGIT	2ND DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD	-	-	.1
SILVER	-	-	.01



TOLERANCE
GOLD ±5%
SILVER ±10%
NO BAND ±20%

EXAMPLES



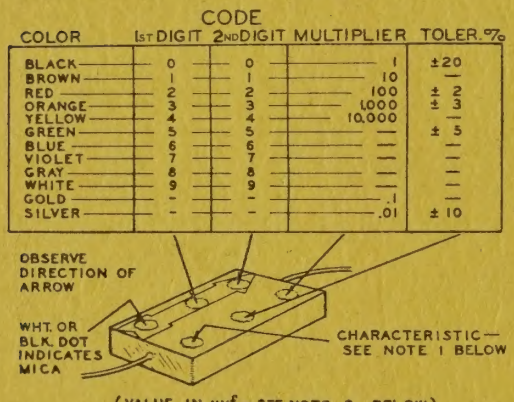
CAPACITORS

Generally, only mica and tubular ceramic capacitors, used in modern equipment, are color coded. The color codes differ somewhat among capacitor manufacturers, however the codes shown below apply to practically all of the mica and tubular ceramic capacitors that are in common use. These codes comply with EIA (Electronics Industries Association) Standards.

MICA

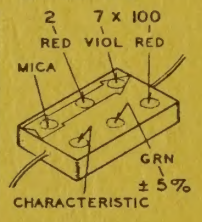
CODE

COLOR	1ST DIGIT	2ND DIGIT	MULTIPLIER	TOLER. %
BLACK	0	0	1	±20
BROWN	1	1	10	—
RED	2	2	100	± 2
ORANGE	3	3	1,000	± 3
YELLOW	4	4	10,000	—
GREEN	5	5	—	± 5
BLUE	6	6	—	—
VIOLET	7	7	—	—
GRAY	8	8	—	—
WHITE	9	9	—	—
GOLD	-	-	.1	—
SILVER	-	-	.01	± 10



(VALUE IN μμf—SEE NOTE 3 BELOW)

EXAMPLE



2,700μμf ±5%
OR .0027 μfd

TUBULAR CERAMIC

Place the group of rings or dots to the left and read from left to right.

CODE

COLOR	1ST DIGIT	2ND DIGIT	MULTIPLIER	TOLER. % (0 OR LESS)	TOLER. % (OVER 10)
BLACK	0	0	1	±20	±20
BROWN	1	1	10	±0.1	±1
RED	2	2	100	—	±2
ORANGE	3	3	1,000	—	±2.5
YELLOW	4	4	10,000	—	—
GREEN	5	5	—	±0.5	±5
BLUE	6	6	—	—	—
VIOLET	7	7	—	—	—
GRAY	8	8	—	±0.25	—
WHITE	9	9	—	±1.0	±10

EXAMPLE

33μμf ±5%

(VALUE IN μμf—SEE NOTE 3 BELOW)

NOTES:

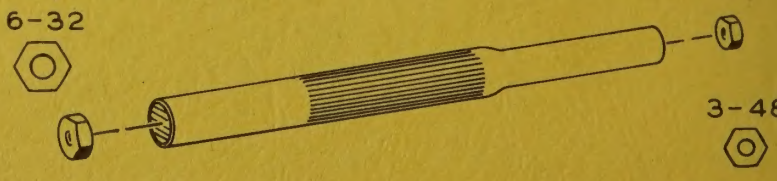
1. The characteristic of a mica capacitor is the temperature coefficient, drift capacitance and insulation resistance. This information is not usually needed to identify a capacitor but, if desired, it can be obtained by referring to EIA Standard, RS-153 (a Standard of Electronic Industries Association.)

2. The temperature coefficient of a capacitor is the predictable change in capacitance with temperature change and is expressed in parts per million per degree centigrade. Refer to EIA Standard, RS-198 (a Standard of Electronic Industries Association.)

3. The farad is the basic unit of capacitance, however capacitor values are generally expressed in terms of μfd (microfarad, .000001 farad) and μμf (micro-micro-farad, .000001 μfd); therefore, 1,000 μμf = .001 μfd, 1,000,000 μμf = 1μfd. The designation pf is sometimes used for μμf.

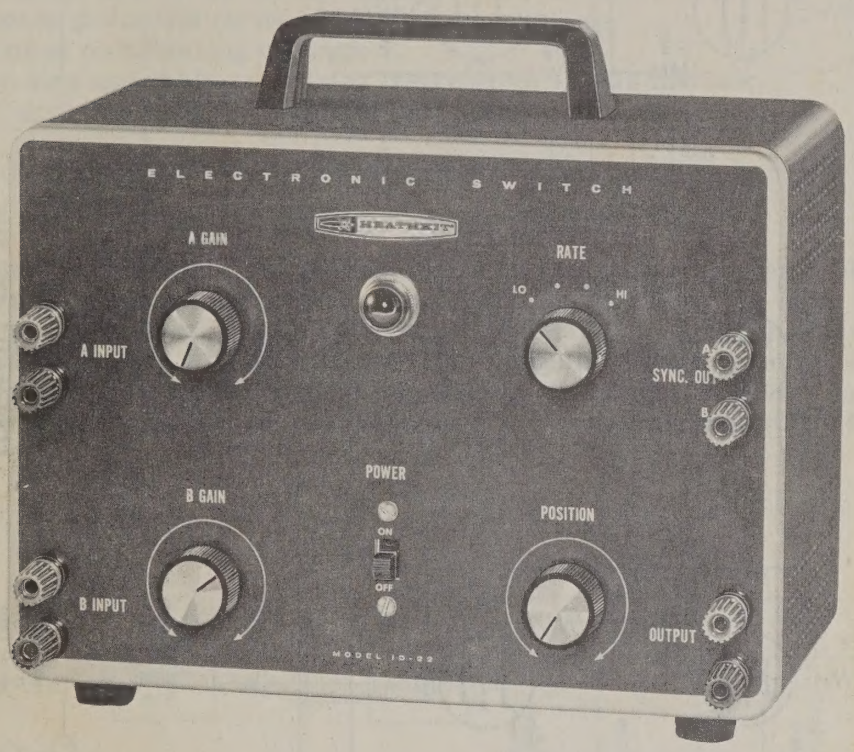
USING A PLASTIC NUT STARTER

A plastic nut starter offers a convenient method of starting the most used sizes: 3/16" and 1/4" (3-48 and 6-32). When the correct end is pushed down over a nut, the pliable tool conforms to the shape of the nut and the nut is gently held while it is being picked up and started on the screw. The tool should only be used to start the nut.



ASSEMBLY AND OPERATION OF THE HEATHKIT ELECTRONIC SWITCH

MODEL ID-22

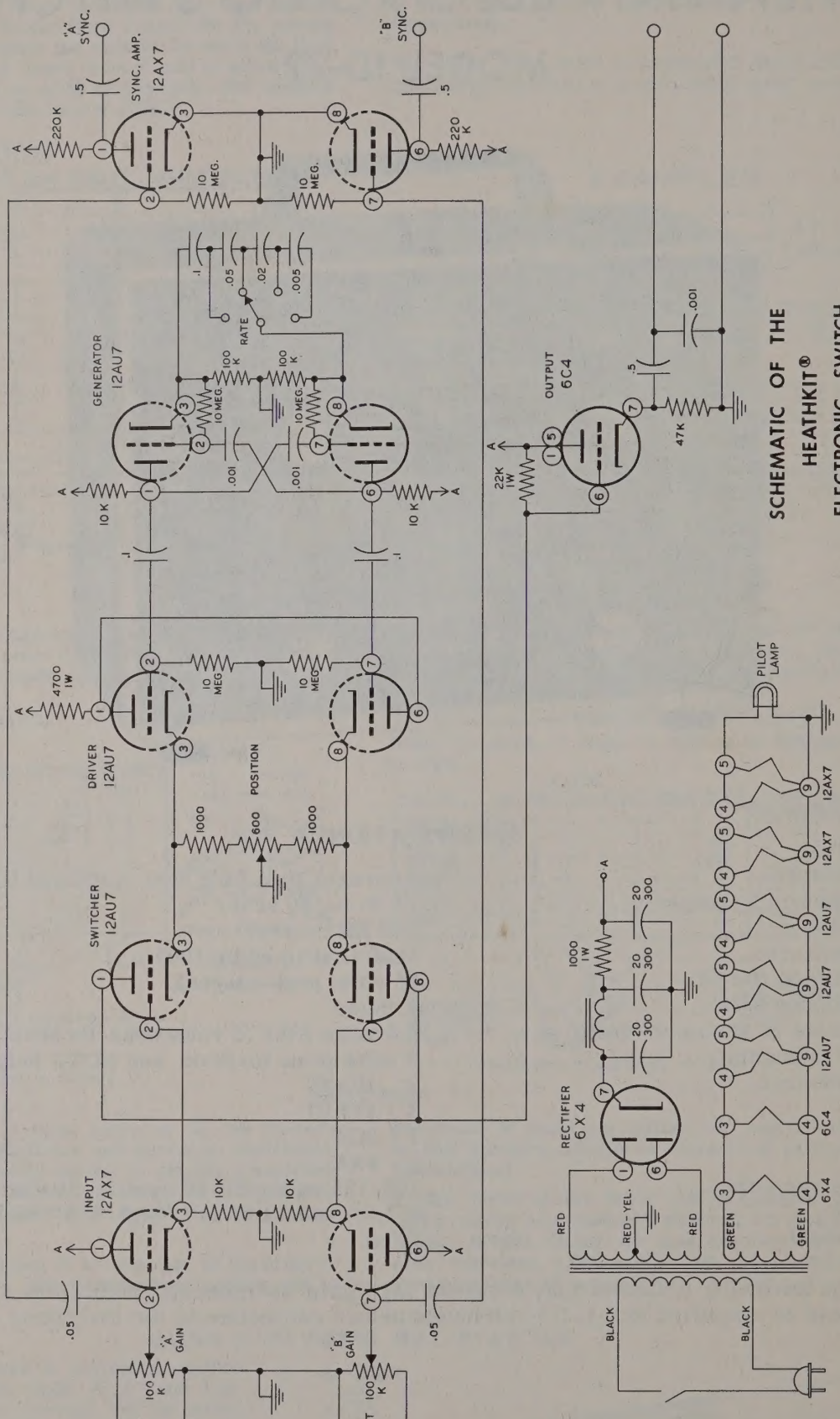


SPECIFICATIONS

Switching Rates:	Approximately 150, 500, 1500 and 5000 cycles
Signal Frequency Response:	±1 db 0-100 kc
Input Impedance:	100 KΩ control
Output Impedance:	1000 Ω shunted by 1000 $\mu\mu$f
Maximum Signal Output:	25 volts peak-to-peak
Maximum Signal Gain:	5 times
Maximum Input at Maximum Gain:	1.8 volts RMS (5 volts peak-to-peak)
Switching Transients:	2 volts peak-to-peak, see NOTE below*.
Tube Complement:	2 - 12AX7
	3 - 12AU7
	1 - 6C4
	1 - 6X4
Power Requirements:	105-125 volts, 50-60 cycles, 30 watts
Dimensions:	9 1/2" wide x 6 1/2" high x 5" deep
Shipping Weight:	8 lbs.

*NOTE: The switching transient may overload high gain oscilloscope amplifiers. Low level signals should be amplified to 0.1-1.0 volt levels before connection to the Electronic Switch.

6/25/65



SCHEMATIC OF THE HEATHKIT® ELECTRONIC SWITCH MODEL ID-22

INTRODUCTION

The Heathkit Electronic Switch model ID-22 is a device which permits simultaneous observation of two signals on your oscilloscope screen.

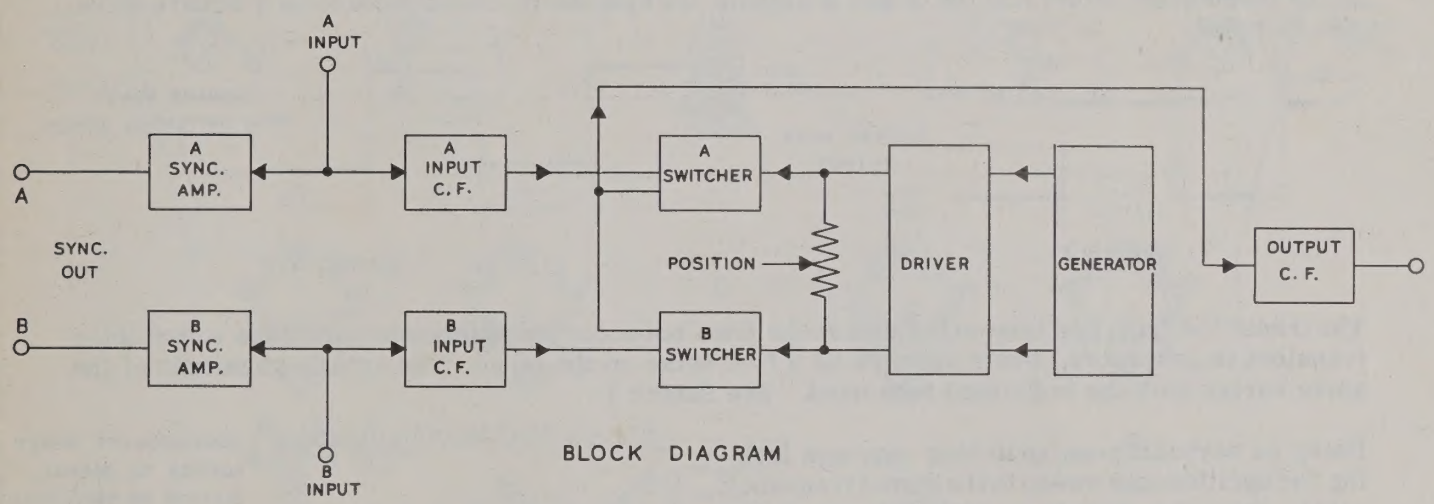
Careful assembly of this kit will provide you with an instrument that for many years will deliver the fine performance of which this design is capable. Such careful assembly is most readily achieved by using as your helpers:

The identification aids on the inside covers of this manual.
The large scale pictorials included with this manual.
The instructions on soldering on Page 8.
The step-by-step assembly and wiring instructions in this manual.
The highest skill and workmanship that only you can provide.

Instrument quality performance requires instrument quality construction.

CIRCUIT DESCRIPTION

The Heathkit Electronic Switch will accommodate two signals and alternately present either one to the output terminals. The alternation from one signal to the other may be made at any one of four switching rates. These rates are determined by four wide-tolerance condensers and thus the chance that they will be harmonically related is negligibly small. It will, therefore, be possible to select a rate sufficiently different from the signal frequency to prevent both the signal and the switching pulse from appearing statically on your oscilloscope screen.

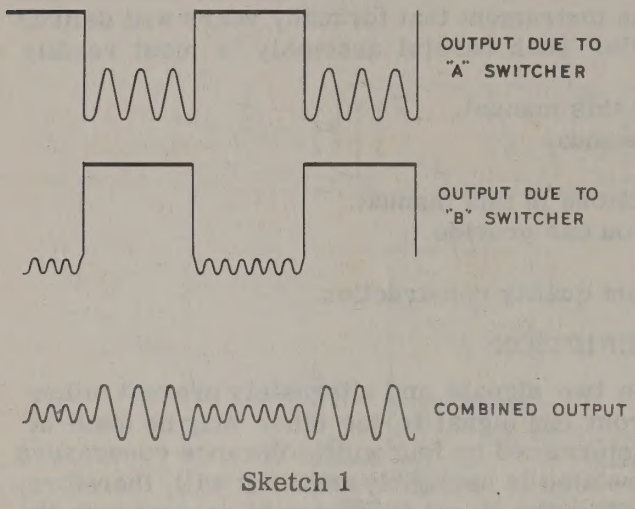


BLOCK DIAGRAM

The Block Diagram shows the basic circuit. A signal applied to the A input may be attenuated to a suitable level. It is then fed to both a sync amplifier and a cathode follower. The sync amplifier output may be used to lock the oscilloscope sweep or time base to the signal frequency through the external sync connection. The cathode follower is directly coupled to the grid of the switching tube.

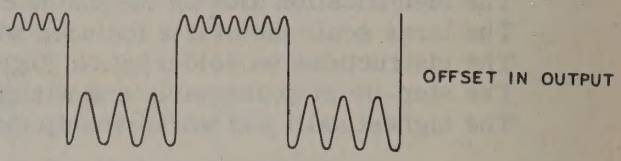
The switch generator produces square waves in the plate circuits of the twin triode. The square wave of one plate is coupled to the grid of one half of the switch driver twin triode. The cathode of the switch driver tube is directly connected to the cathode of the switcher tube. The square wave alternately permits the switcher tube to operate normally or drives it into cut-off. The square wave of the other plate of the generator performs similarly for the other half of the switch driver and the switcher for the B signal.

When the A switcher is amplifying normally, the B switcher is cut off. When the A switcher is cut off, the B switcher is amplifying normally. The plates of the A and B switchers are connected together and fed through a common load resistor. Thus the A and B signals will appear alternately across the load resistor. See Sketch 1.



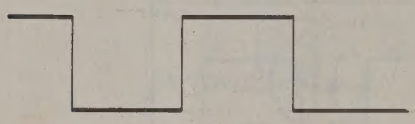
Sketch 1

If the switcher tubes operate with different bias values the normal plate currents will vary, as will the plate voltages and the outputs will be offset. See Sketch 2.

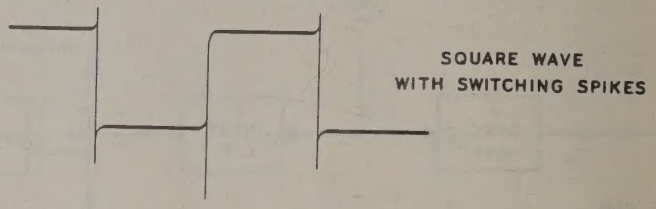


Sketch 2

If the outputs are offset and the A and B signals are both zero, the output will be a square wave. See Sketch 3.



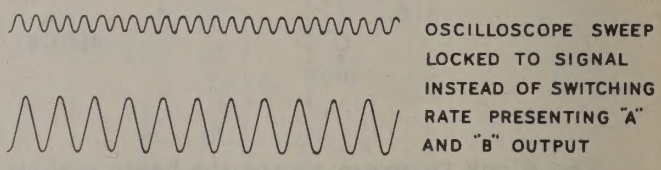
Sketch 3



Sketch 4

The transition from one tube to the other tube does not occur instantaneously and thus a switching transient is generated, which appears as a fine spike on the trace. The actual magnitude of the spike varies with the individual tube used. See Sketch 4.

Using an asynchronous switching rate and locking the oscilloscope sweep to the signal frequency rather then the switching rate will mask the switching wave and transients and present only the A and B signals.



Sketch 5

The position control varies the operating bias and the offset. The traces may thus be separated or made to overlap each other on the oscilloscope screen.

The signals at the switcher plates are directly coupled to the grid of a cathode follower tube. The output of the cathode follower is fed through a large condenser to the output binding post.

The output terminals are shunted by a condenser to reduce the switching transients. The high frequency response is restricted by this condenser. Increased high frequency response (and larger transient spikes) may be obtained by omitting the condenser. Conversely, for low frequency applications a larger value condenser may be used to effectively eliminate the transients. Values larger than .01 μfd will do little to reduce the transient but may impair the quality of the presentation by rounding and tilting of the switching square wave.

STEP-BY-STEP ASSEMBLY

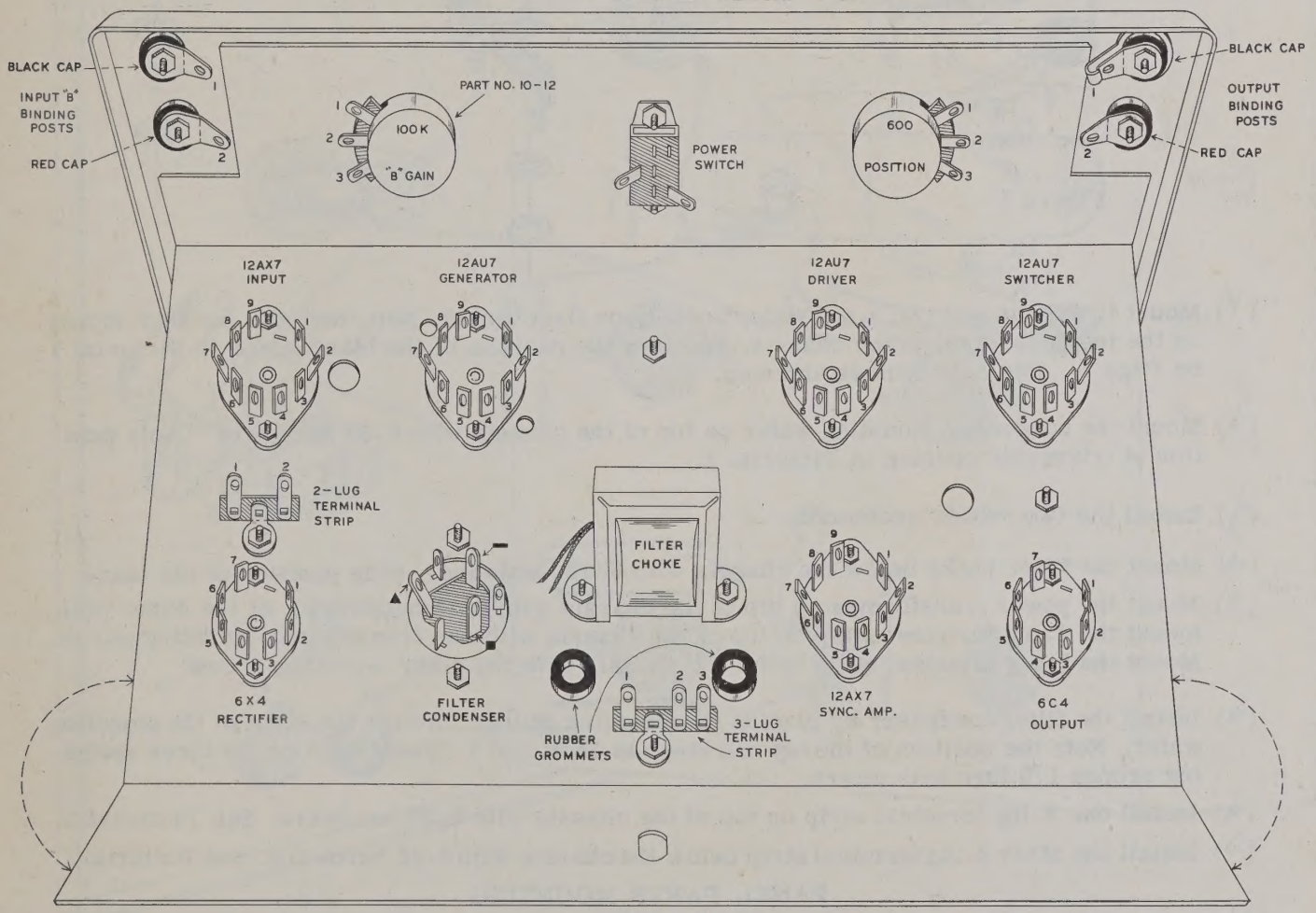
A kit of parts can be assembled into the finished product in a variety of ways; from pictorials, photographs or the circuit diagram alone. However, even skilled and professional persons have discovered that a combination of pictorials and step-by-step written instructions provide the fastest, most convenient way. It also guards against the disappointment of failure to operate after construction is completed, because of a single, hard-to-find omission.

The written assembly instructions in this manual are divided into small operations or steps. Each step is a complete operation. Read the entire step through, then do that operation and check it off as it is completed. After an interruption, it is easy to find where you left off by the check marks. Read over the last checked step and you are all ready to continue.

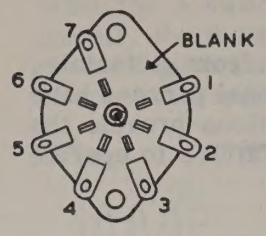
The major pictorials in this manual are reproduced on large scale separate sheets. Fasten the appropriate pictorial on the wall over your work space. This will save you paging back and forth in the manual.

In the mechanical assembly, use lockwashers under all 6-32 nuts and between all controls or switches and the mounting surface.

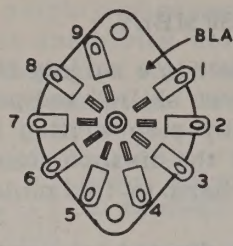
In the wiring (S) means solder this connection; (NS) means do not solder yet as more wires will be connected to this point. If more than one wire is soldered to one point, soldering instructions will read as follows: (S-3) meaning solder this connection which has three wires running to it. This will provide a running check on multiple connections.



PICTORIAL 1



7-PIN SOCKET



9-PIN SOCKET

Figure 1

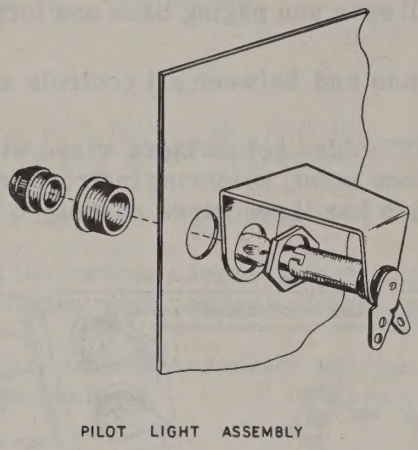


Figure 3

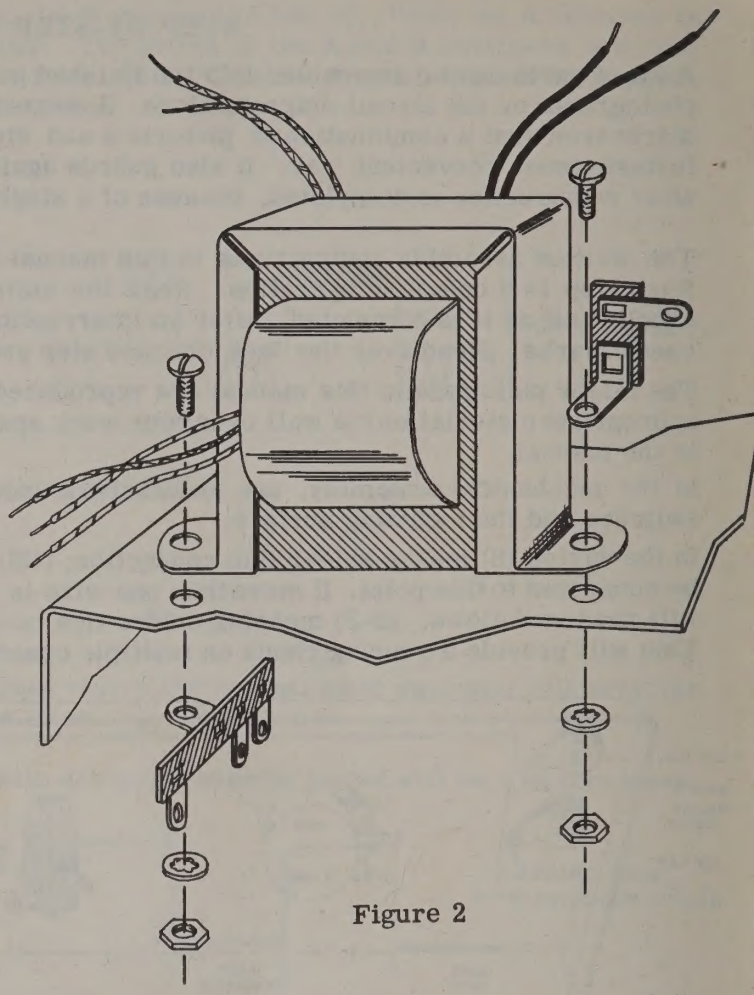


Figure 2

( ) Mount five 9-pin and two 7-pin wafer sockets on the chassis. Note that the sockets mount on the inside (bottom) of the chassis. Observe the position of the blank space in Pictorial 1 on Page 5. Use 3-48 screws and nuts.

( ) Mount the condenser mounting wafer on top of the chassis with 6-32 hardware. Note position of triangular opening in Pictorial 1.

( ) Install the two rubber grommets.

( ) Mount the filter choke below the chassis with 6-32 hardware. Note position of the leads.

( ) Mount the power transformer on top of the chassis with 6-32 hardware. At the same time, mount the 1-lug terminal strip on top of the chassis with one transformer mounting screw. Mount the 3-lug terminal strip below the chassis with the other mounting screw.

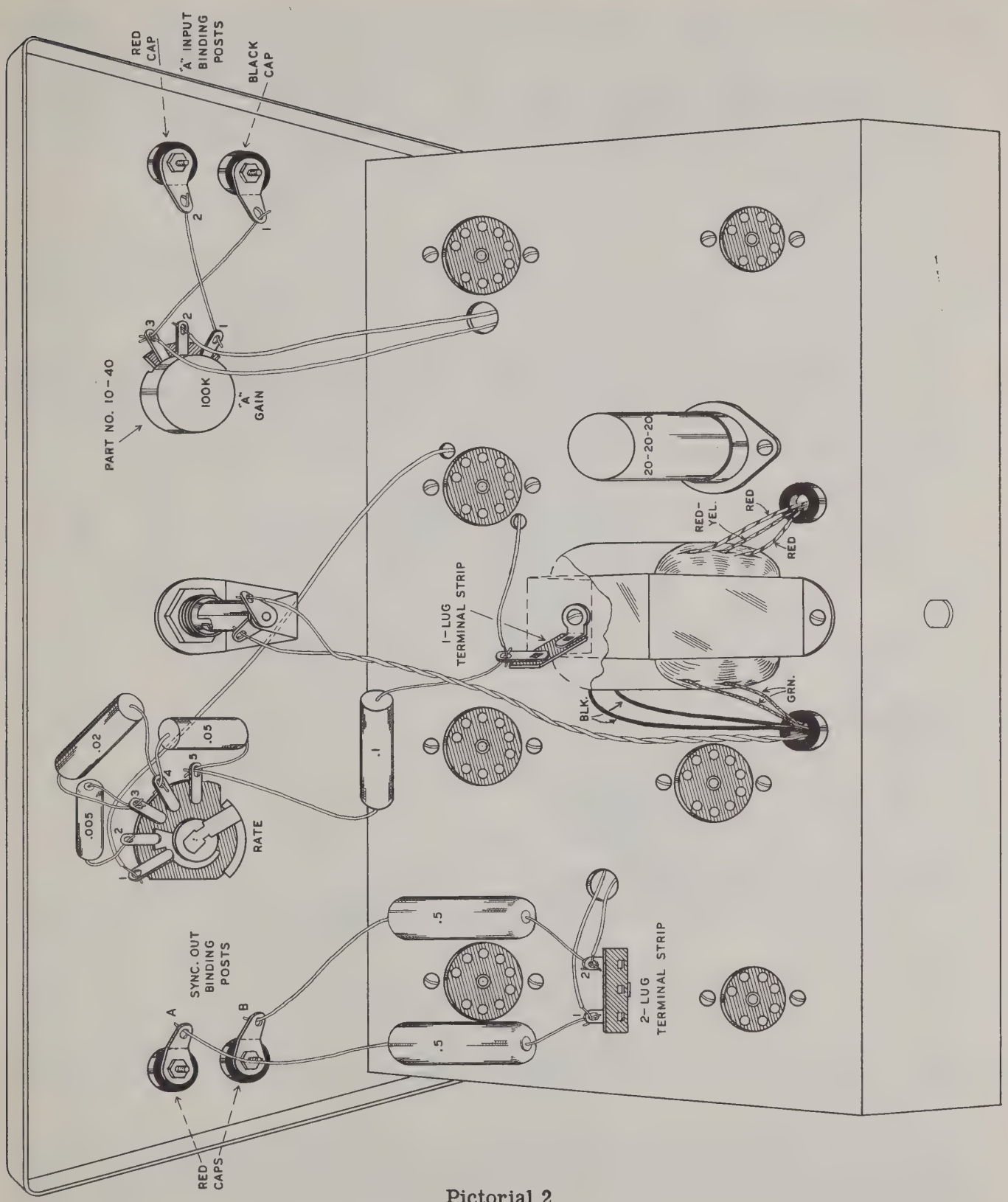
( ) Install the filter condenser by placing the mounting prongs through the slots in the mounting wafer. Note the position of the lug markings in Pictorial 1. Twist each of the three mounting prongs 1/8 turn with pliers.

( ) Install one 2-lug terminal strip on top of the chassis with 6-32 hardware. See Pictorial 2.

( ) Install the other 2-lug terminal strip below the chassis with 6-32 hardware. See Pictorial 1.

PANEL PARTS MOUNTING

( ) Install the pilot light assembly on the panel as in Figure 3. See Pictorial 2 on Page 7 for position.


RED CAP
"A" INPUT BINDING POSTS
BLACK CAP
PART NO. 10-40
100K
"A" GAIN
20-20-20
RED-YEL.
RED
RED
1-LUG TERMINAL STRIP
BLK.
GRN.
.02
.05
.005
.1
RATE
.5
.5
2-LUG TERMINAL STRIP
SYNC. OUT BINDING POSTS
A
B
RED CAPS

Pictorial 2

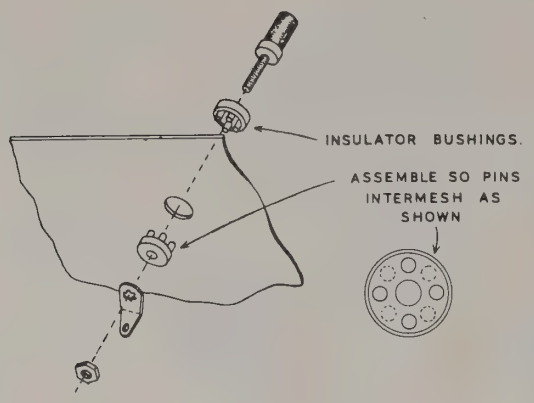


Figure 4

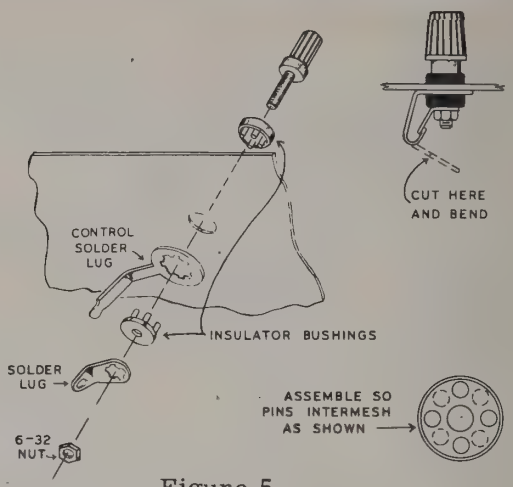
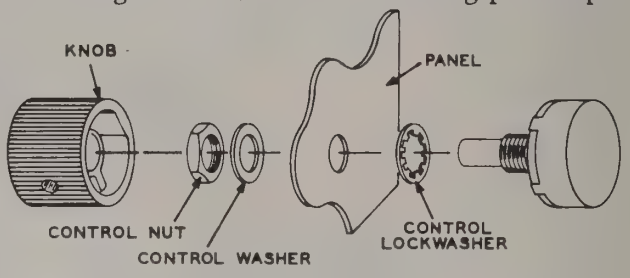


Figure 5

( ) Install the binding posts as shown in Figure 4, using binding post base, insulator bushings, solder lug and nut in seven places. In the last place, at the corner of the panel marked OUTPUT, include a control solder lug as shown in Figure 5. Install the binding post caps.

( ) Install the 100 KΩ control with the short threaded bushing (part #10-40) on the panel in the hole marked A GAIN. Use a control lockwasher between control and panel and a nickel washer between the panel and the control nut. See Pictorial 2.

( ) Install the 4-position switch on the panel in the hole marked RATE in the same manner.



HOW TO MOUNT CONTROLS, SWITCH, AND KNOBS

Figure 6

PANEL TO CHASSIS ASSEMBLY

( ) Install the slide switch with 6-32 hardware. Line up the control holes in panel and chassis before tightening the screws. Observe the position of the lugs on the switch.

( ) Install the 100 KΩ control with the long threaded bushing (part #10-12) through the chassis and panel in the hole marked B GAIN.

( ) Position the 600 Ω control in the same manner in hole marked POSITION. Bend down locating tab.

( ) Turn the switch and control shafts fully counterclockwise.

( ) Install a knob on each of the switch and control shafts so the pointer is at the extreme counterclockwise marking of the panel and tighten the setscrew.

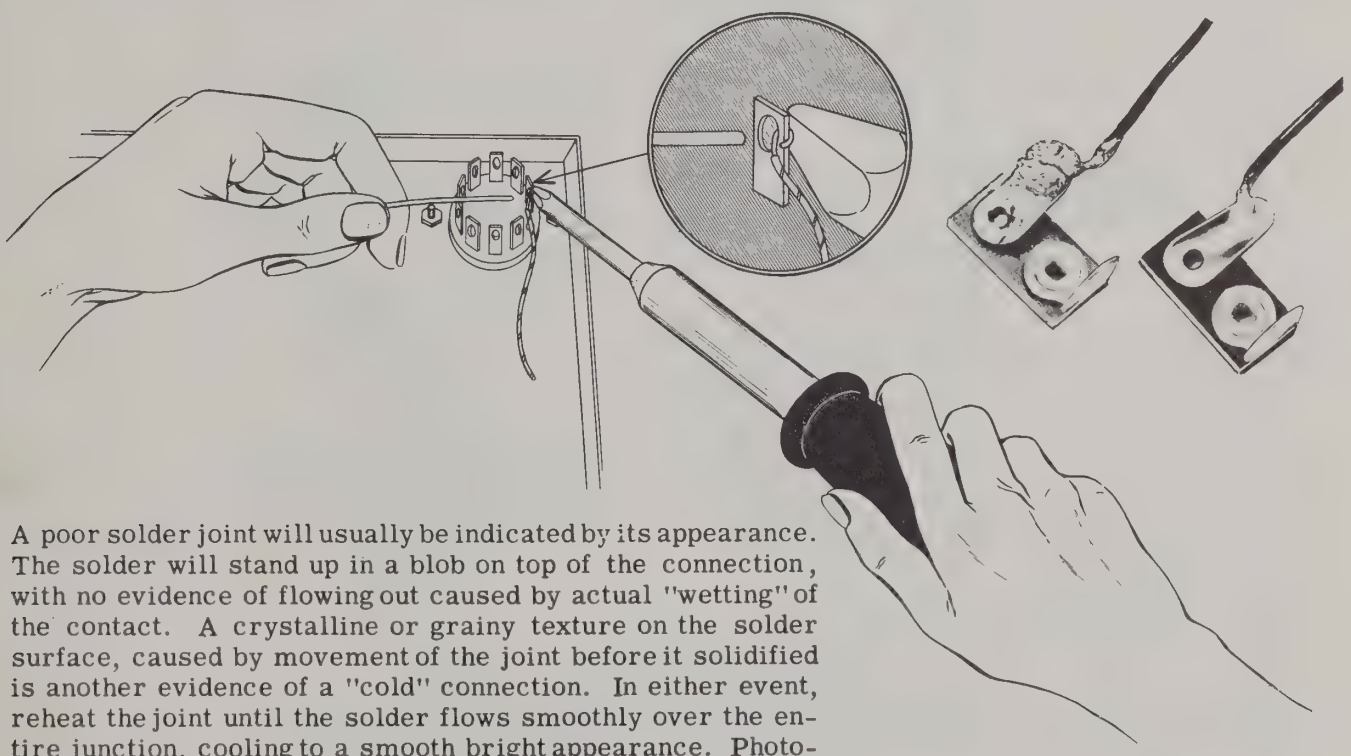
PROPER SOLDERING PROCEDURE

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly because of poor or improper soldering.

Correct soldering technique is extremely important. Good solder joints are essential if the performance engineered into the kit is to be fully realized. If you are a beginner with no experience in soldering, a half-hour's practice with odd lengths of wire and a tube socket will be a worthwhile investment.

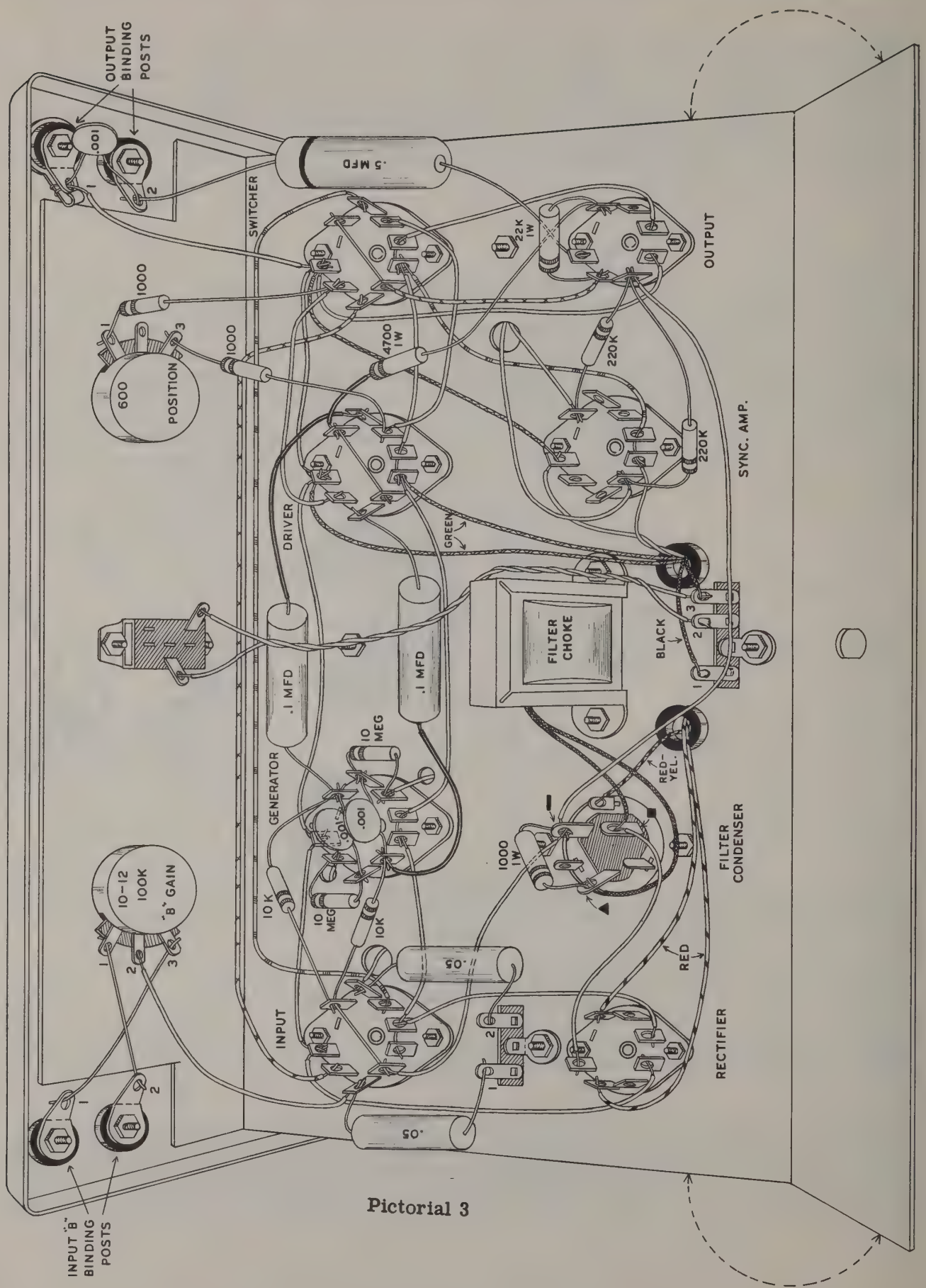
ROSIN CORE SOLDER HAS BEEN SUPPLIED WITH THIS KIT. THIS TYPE OF SOLDER MUST BE USED FOR ALL SOLDERING IN THIS KIT. ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE EQUIPMENT IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. IF ADDITIONAL SOLDER IS NEEDED, BE SURE TO PURCHASE ROSIN CORE (60:40 or 50:50 TIN-LEAD CONTENT) RADIO TYPE SOLDER.

If terminals are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so that a good joint is made without relying on solder for physical strength. To make a good solder joint, the clean tip of the soldering iron should be placed against the joint to be soldered so that the terminal is heated sufficiently to melt solder. The solder is then placed against both the terminal and the tip of the iron and will immediately flow out over the joint. Refer to the sketch below. Use only enough solder to cover wires at the junction; it is not necessary to fill the entire hole in the terminal with solder. Excess solder may flow into tube socket contacts, ruining the socket, or it may creep into switch contacts and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.



A poor solder joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface, caused by movement of the joint before it solidified is another evidence of a "cold" connection. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth bright appearance. Photographs in the adjoining picture clearly indicate these two characteristics.

A good, clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 25 to 100 watt iron, or the equivalent in a soldering gun, is very satisfactory. Smaller irons generally will not heat the connections enough to flow the solder smoothly over the joint and are recommended only for light work, such as on etched circuit boards, etc. Keep the iron tip clean and bright. A pad of steel wool may be used to wipe the tip occasionally.


OUTPUT BINDING POSTS
.001
.5 MFD
SWITCHER
22K 1W
OUTPUT
1000
4700 1W
220K
POSITION
600
1000
220K
SYNC. AMP.
DRIVER
GREEN
FILTER CHOKE
BLACK
.1 MFD
.1 MFD
10 MEG
GENERATOR
.001
.001
RED-YEL.
1000 1W
FILTER CONDENSER
10-12 100K "B" GAIN
10 K
10 MEG
10K
.05
RED
INPUT
.05
RECTIFIER
INPUT "B" BINDING POSTS

Pictorial 3

Take these precautions and use reasonable care during the assembly of the kit. This will insure the wonderful satisfaction of having the instrument operate perfectly the first time it is turned on.

WIRING THE INSTRUMENT

( ) Cut the red-yellow lead from the transformer to the correct length and after placing it through the grommet, connect it to the nearest twisted mounting prong (S) on the filter condenser.

( ) Cut the two red leads from the transformer to the correct length and after placing them through the grommet connect one lead to pin 1 (S) and the other lead to pin 6 (S) on the 6X4 socket.

( ) Cut the two black leads to the correct length and after placing them through the second grommet, connect one lead to lug 1 (NS) and the other lead to lug 3 (NS) on the 3-lug terminal strip.

( ) Cut the two green leads to the correct length and after placing them through the second grommet, connect one lead to pin 5 (NS) and the other lead to pin 9 (NS) on the 12AU7 switch driver tube socket.

( ) Twist two 8" lengths of wire together and connect one end to the 12AX7 sync amplifier socket with one wire to pin 9 (NS) and the other wire to pin 5 (NS). Pass the wire through the nearest grommet. Connect the other end to the pilot light socket with one wire to each lug. Solder both leads.

( ) Connect a 3 1/2" wire between pin 9 (S-2) on the sync amplifier socket and pin 9 (NS) on the 12AU7 switcher tube socket.

( ) Connect another 3 1/2" wire between pin 5 (NS) on the switcher socket, through pin 4 (S) to pin 5 (S-2) on the sync amplifier socket.

( ) Connect a 4" wire between pin 4 (S) on the 6C4 output cathode follower tube socket and pin 9 (NS) on the switcher socket.

( ) Connect a 3" wire between pin 3 (S) on the output socket and through pin 4 (S) to pin 5 (NS) on the switcher socket.

( ) Connect a 2 1/2" wire between pin 5 (S-3) on the switcher socket and through pin 4 (S) to pin 5 (NS) on the driver socket.

( ) Connect a 3" wire between pin 9 (NS) on the switcher socket and both large and small solder lugs (NS) on output binding post 1.

( ) Connect a 2 1/2" wire between pin 9 (S-4) on the switcher socket and pin 9 (NS) on the driver socket.

( ) Connect a 3 1/2" wire between pin 5 (S-3) on the driver socket and through pin 4 (S) to pin 5 (NS) on the 12AU7 switch generator socket.

( ) Connect another 3 1/2" wire between pin 9 (S-3) on the driver socket and pin 9 (NS) on the generator socket.

( ) Connect a 2 1/2" wire between pin 5 (S-2) on the generator socket and through pin 4 (NS) to pin 5 (S) on the 12AX7 input cathode follower socket.

( ) Connect another 2 1/2" wire between pin 9 (S-2) on the generator socket and pin 9 (NS) on the input socket.

( ) Connect a 4" wire between pin 9 (S-2) on the input socket and pin 4 (S) on the 6X4 rectifier socket.

( ) Connect a 3" wire between pin 4 (S-2) on the input socket and pin 3 (S) on the rectifier socket.

( ) Connect another 3" wire between pin 7 (S) on the rectifier socket and the ■ marked lug (NS) on the filter condenser.

( ) Cut one lead of the filter choke to the correct length and connect to the ■ marked lug (S-2) on the filter condenser.

( ) Cut the other lead of the filter choke to the correct length and connect to the ▲ marked lug (NS) on the filter condenser.

( ) Connect a 6" wire between the unmarked lug (NS) on the filter condenser and pin 5 (NS) on the output socket.

( ) Connect a 3" wire between the unmarked lug (NS) on the filter condenser and pin 6 (NS) on the input socket.

( ) Connect a 10" wire between pin 8 (NS) on the input socket and pin 7 (S) on the switcher socket.

( ) Connect another 10" wire between pin 3 (NS) on the input socket and pin 2 (S) on the switcher socket.

( ) Connect a 3" wire between pin 8 (S) on the driver socket and pin 8 (NS) on the switcher socket.

( ) Connect another 3" wire between pin 3 (NS) on the driver socket and pin 3 (S) on the switcher socket.

( ) Connect a 3 1/2" wire between pin 6 (NS) on the output socket and through pin 6 (S) to pin 1 (S) on the switcher socket.

( ) Connect a 2 1/2" wire between pin 1 (NS) on the sync amplifier socket and lug 1 (NS) on the 2-lug terminal strip on top of the chassis.

( ) Connect a 3 1/2" wire between pin 6 (NS) on the sync amplifier socket and lug 2 (NS) on the 2-lug terminal strip on top of the chassis.

( ) Connect a 2 1/2" wire between pin 7 (NS) on the input socket and lug 2 (S) on the B GAIN control.

( ) Connect a 3" wire between pin 2 (NS) on the input socket and lug 2 (S) on the A GAIN control.

( ) Connect a 2 1/2" wire between pin 3 (NS) on the generator socket and the 1-lug terminal strip (NS) on top of the chassis.

( ) Connect a 7" wire between pin 8 (NS) on the generator socket and lug 1 (S) on the RATE switch.

( ) Connect a short bare wire between the solder lug (NS) on INPUT B binding post 1 and lug 3 (S) on the B GAIN control.

( ) Connect another short bare wire between the solder lug (S) on INPUT B binding post 2 and lug 1 (S) on the B GAIN control.

( ) Connect a third short bare wire between the solder lug (S) on INPUT A binding post 1 and lug 3 (NS) on the A GAIN control.

( ) Connect a fourth short bare wire between the solder lug (S) on INPUT A binding post 2 and lug 1 (S) on the A GAIN control.

( ) Connect a .5 μfd condenser between the solder lug (S) on sync binding post B and lug 2 (S-2) on the 2-lug terminal strip on top of the chassis. Place this condenser against the chassis in such a way that it will not interfere with the switcher tube.

( ) Connect another .5 μfd condenser between the solder lug (S) on sync binding post A and lug 1 (S-2) on the 2-lug terminal strip, observing the same care as above.

( ) Connect a .1 μfd condenser between the 1-lug terminal strip (S-2) and lug 5 (NS) on the RATE switch.

( ) Connect a .05 μfd condenser between lug 5 (S-2) and lug 4 (NS) on the RATE switch.

( ) Connect a .02 μfd condenser between lug 4 (S-2) and lug 3 (NS) on the RATE switch.

( ) Connect a .005 μfd condenser between lug 3 (S-2) and lug 2 (S) on the RATE switch.

( ) Connect a .1 μfd condenser between pin 1 (NS) on the generator socket and pin 2 (NS) on the driver socket. Use sleeving on the second lead.

( ) Connect another .1 μfd condenser between pin 6 (NS) on the generator socket and pin 7 (NS) on the driver socket. Use sleeving over the first lead.

( ) Connect a 10 megohm resistor between pin 2 (NS) and pin 3 (NS) on the generator socket.

( ) Connect a .001 μfd condenser between pin 2 (S-2) and pin 6 (NS) on the generator socket.

( ) Connect a 10 KΩ resistor between pin 6 (S-3) on the generator socket and through pin 1 (NS) to pin 6 (S-2) on the input socket.

( ) Connect a 10 megohm resistor between pin 7 (NS) and pin 8 (NS) on the generator socket.

( ) Connect a .001 μfd condenser between pin 7 (S-2) and pin 1 (NS) on the generator socket.

( ) Connect a 10 KΩ resistor between pin 1 (S-3) on the generator socket and pin 1 (S-2) on the input socket.

( ) Connect a .05 μfd condenser between pin 7 (S-2) on the input socket and lug 1 (NS) on the adjacent 2-lug terminal strip.

( ) Connect another .05 μfd condenser between pin 2 (S-2) on the input socket and lug 2 (NS) on the 2-lug terminal strip.

( ) Connect a 1000 Ω 1 watt resistor between the ▲ marked lug (S-2) and the unmarked lug (S-3) on the filter condenser.

( ) Connect a 220 KΩ resistor between pin 5 (NS) on the output socket and pin 1 (S-2) on the sync amplifier socket.

( ) Connect another 220 KΩ resistor between pin 5 (S-3) on the output socket and pin 6 (S-2) on the sync amplifier socket.

( ) Connect a short bare wire between pin 6 (S) and pin 1 (NS) on the driver socket.

( ) Connect a 4700 Ω 1 watt resistor between pin 1 (S-2) on the driver socket and pin 1 (NS) on the output socket. Use sleeving over the first lead.

( ) Connect a 22 KΩ 1 watt resistor between pin 1 (S-2) and pin 6 (S-2) on the output socket.

( ) Connect a 1000 Ω resistor between pin 3 (S-2) on the driver socket and lug 3 (S) on the POSITION control.

( ) Connect another 1000 Ω resistor between pin 8 (S-2) on the switcher socket and lug 1 (S) on the POSITION control.

( ) Connect a .5 μfd condenser between pin 7 (NS) on the output socket and the solder lug (NS) on output binding post 2.

( ) Connect a .001 μfd condenser between the solder lug (S-2) on output binding post 2 and both solder lugs (NS) on output binding post 1.

The ground circuit in this instrument uses a heavy wire bus placed 1 3/4" below the chassis level. All components connecting to ground will be tied to this bus and they in turn will support it. The following parts and wires should be connected with this in mind. See Pictorial 4, Page 15.

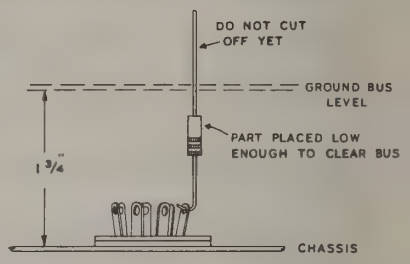


Figure 7

( ) Connect a 47 KΩ resistor upright to pin 7 (S-2) on the output socket.

( ) Connect a 10 megohm resistor upright to pin 2 (NS) on the sync amplifier socket.

( ) Connect another 10 megohm resistor upright to pin 7 (NS) on the sync amplifier socket.

( ) Connect a third 10 megohm resistor upright to pin 2 (S-2) on the driver socket.

( ) Connect a fourth 10 megohm resistor upright to pin 7 (S-2) on the driver socket.

( ) Connect a 100 KΩ resistor upright to pin 3 (S-3) on the generator socket.

( ) Connect another 100 KΩ resistor upright to pin 8 (S-3) on the generator socket.

( ) Connect a 10 KΩ resistor upright to pin 3 (S-2) on the input socket.

( ) Connect another 10 KΩ resistor upright to pin 8 (S-2) on the input socket.

( ) Connect a bare wire upright to a twisted mounting prong (S) on the filter condenser.

( ) Connect another bare wire through pin 3 (S) and pin 8 (S) on the sync amplifier socket and bend upright.

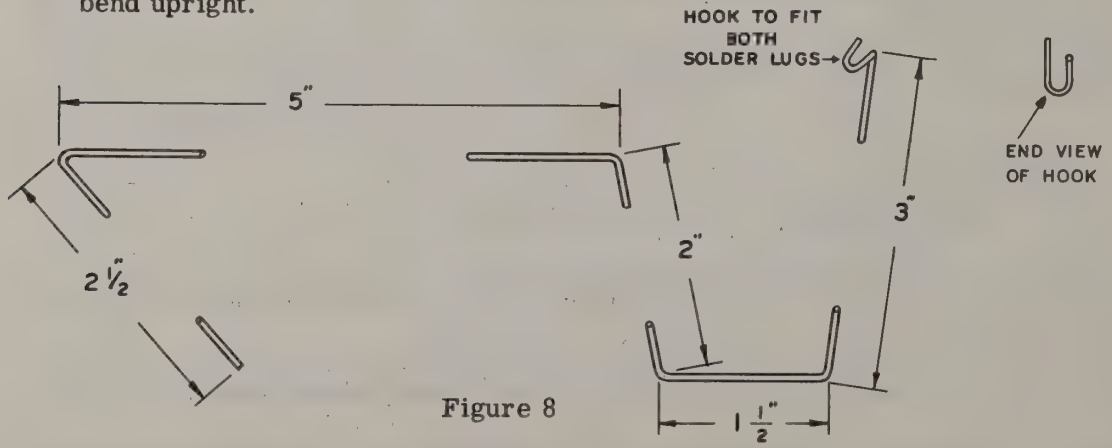
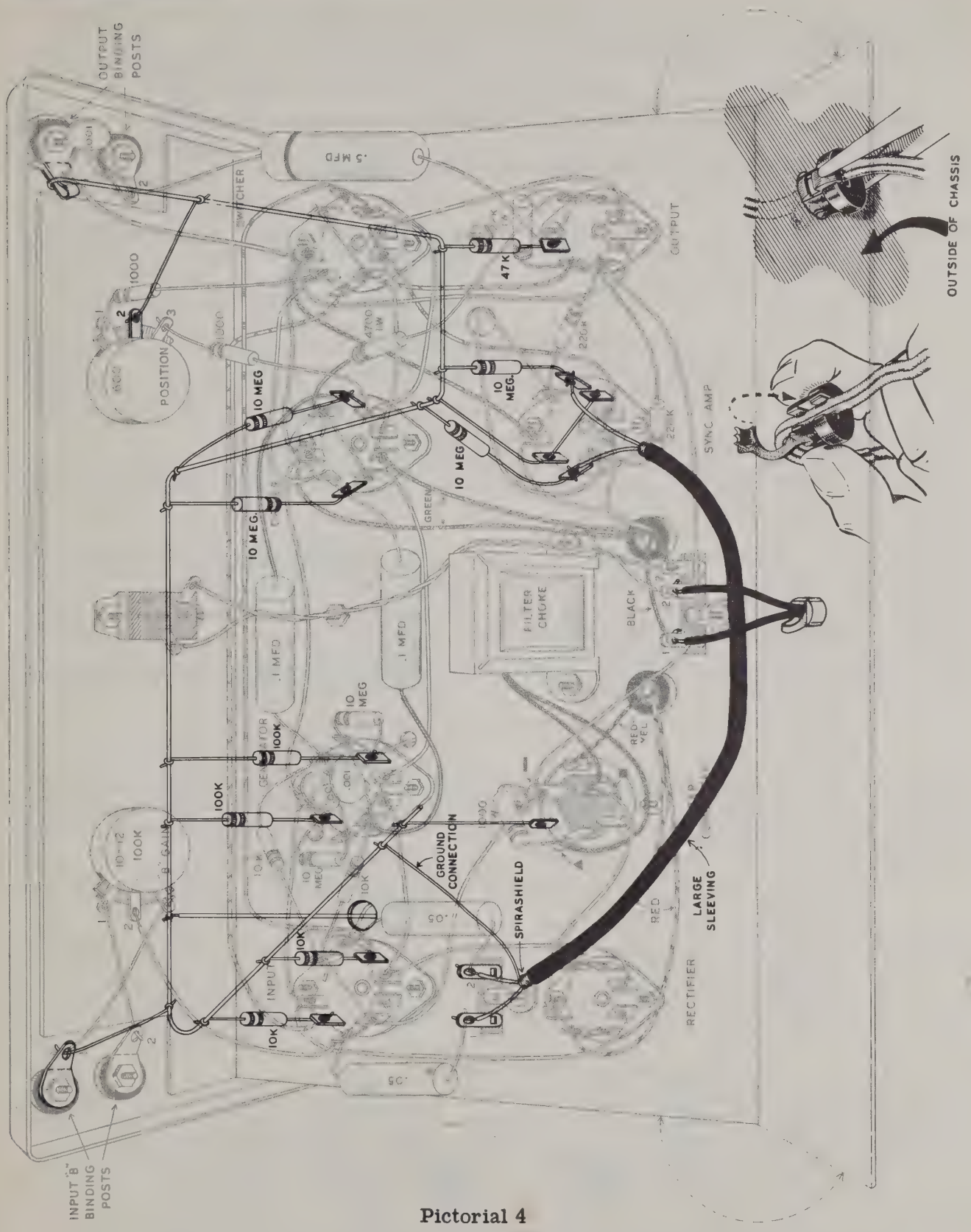


Figure 8

NOTE: Full-size bus template appears on the large fold-ins.


OUTPUT BINDING POSTS
.5 MFD
SWITCHER
1000
POSITION
10 MEG
10 MEG.
10 MEG
10 MEG.
47 K
OUTPUT
220K
22K
SYNC AMP
GREEN
.1 MFD
.1 MFD
FILTER CHOKE
BLACK
RED-YEL
100K
100K
100K
10K
10K
10K
GROUND CONNECTION
SPIRASHIELD
LARGE SLEEVING
RED
RECTIFIER
OUTSIDE OF CHASSIS
INPUT "B" BINDING POSTS

Pictorial 4

( ) Form the heavy bare wire as shown in Figure 8 and install by slipping the hook around the two solder lugs (S-3) on output binding post 1. Full size bus template appears on fold-ins.

( ) Bend all the upright leads around the bus and solder all eleven connections. See Figure 9. Cut off excess leads.

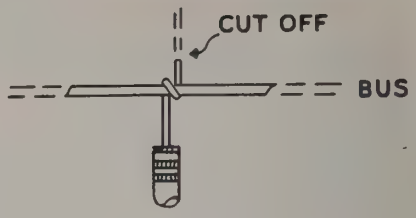


Figure 9

( ) Connect a short bare wire between lug 2 (S) on the POSITION control and the ground bus (S).

( ) Connect another short bare wire between the solder lug (S-2) on input B binding post 1 and the ground bus (S).

( ) Connect a 5" wire between lug 3 (S-2) on the A GAIN control and the ground bus (S).

( ) Twist two 5" lengths of wire together and connect one end to the slide switch with a wire to each lug (S). Connect the other end to the 3-lug terminal strip with one wire to lug 2 (NS) and the other wire to lug 3 (S-2).

( ) Install the line cord through the hole in the rear of the chassis. Connect one lead to lug 1 (S-2) and the other lead to lug 2 (S-2) on the 3-lug terminal strip.

( ) Refer to the inset of Pictorial 4 and install the line cord strain relief.

( ) Connect an 8" wire with one end to pin 7 (S-2) on the sync amplifier socket. Leave the other end loose.

( ) Cut the spirashield and large sleeving to 8".

( ) Unwind about 2" of the Spirashield. (CAUTION: This is copper wire, do not stretch.) Slip the large sleeving over it. The unwound part will be the ground connection.

( ) Slip the shield over the wire with the ground connection last. Now connect the wire to lug 1 (S-2) on the 2-lug terminal strip near the input socket.

( ) Connect an 8" wire between pin 2 (S-2) on the sync amplifier socket and after placing it through the Spirashield to lug 2 (S-2) on the 2-lug terminal strip.

( ) Connect the ground connection of the Spirashield to the ground bus (S).

NOTE: The blue and white identification label shows the Model Number and Production Series Number of your kit. Refer to these numbers in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

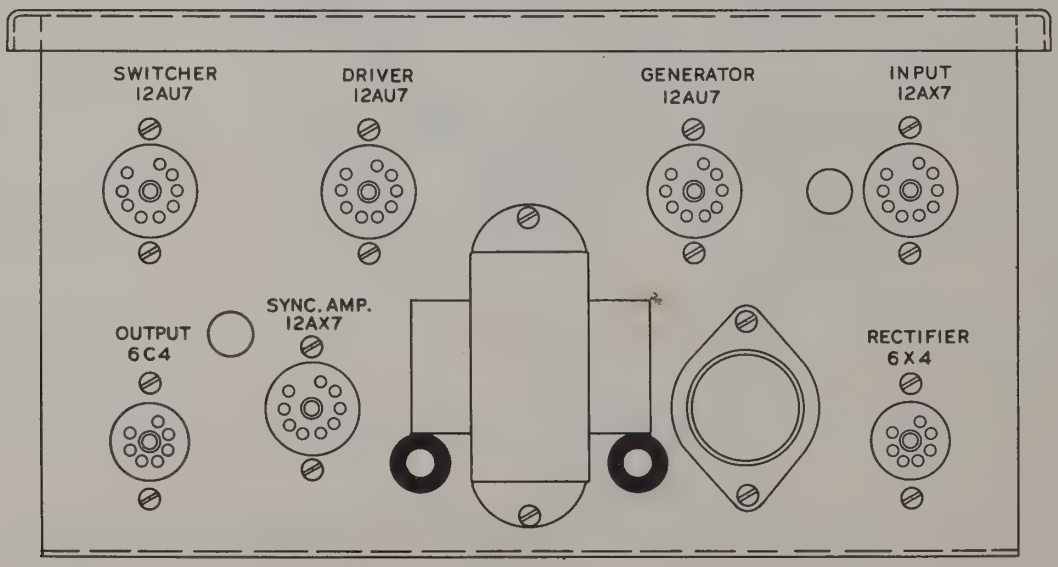


Figure 10

(✓) Install the identification label in the following manner:

1. Select a location for the label where it can easily be seen when needed, but will not show when the unit is in operation. This location might be on the rear panel or the top of the chassis, or on the rear or bottom of the cabinet.
2. Carefully peel away the backing paper. Then press the label into position.

( ) Install the tubes in their proper sockets. See Figure 10 on Page 16.

(✓) Install the handle on the cabinet with #10 x 1/2" sheet metal screws.

(✓) Install the rubber feet in the four holes in the bottom of the cabinet. See Figure 11. Use 6-32 x 1/2" screws, #8 flat washers, #6 lockwashers, and 6-32 nuts.

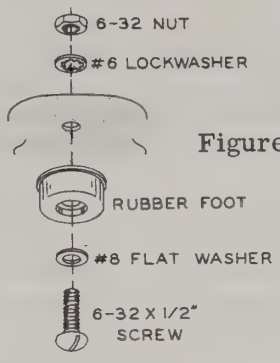


Figure 11

This completes the wiring of the instrument.

INITIAL TESTS

Shake out all wire trimmings and loose particles of solder. Inspect the wiring carefully for lead dress or positioning of the wiring. Inspect each solder joint.

Plug the line cord into a 105-125 volt 50-60 cycle AC outlet. DO NOT plug into a source of higher voltage or lower frequency, or a DC outlet, as an incorrect power source will damage the transformer. Turn the power switch on and observe the tubes and the pilot lamp light up. If they do not, turn the power off and investigate the filament circuit wiring.

Testing the instrument for switching:

Connect the output terminals of the instrument to the vertical input terminals of an oscilloscope. Observe a pair of horizontal lines that can be merged into one line by adjustment of the POSITION control on the electronic switch. Set the POSITION control for two lines and adjust the oscilloscope to show the square wave. Inspect the wave shape for all four switching RATE positions. This shape may not be fully square during this initial test but after a few hours of operation, it will be found that the tubes adjust themselves to the circuit and produce a substantially square wave on all RATE settings.

Testing the amplifier and sync channel:

Apply a test signal to the instrument. This signal may be obtained from an audio generator or from the filament supply of the electronic switch. If a generator is not available, connect a lead between the red A INPUT binding post and a lug on the pilot light socket. Turn the A GAIN control 1/3 on. If no change is observed on the oscilloscope, try the other lug on the pilot light.

Adjust the oscilloscope for a presentation of several nearly stationary cycles of the signal frequency. Connect the A SYNC OUT to the external sync input on the oscilloscope and switch to external sync. Note that the signal wave can readily be "locked-in."

Vary the switching rate and observe that the signal remains stationary with varying appearances of the line trace. At least one rate should give an adequate simulation of a continuous line. Repeat these tests for the B channel.

Install the instrument in the cabinet with two #6 sheet metal screws through the back of the cabinet into the chassis.

APPLICATION

An electronic switch is generally used to observe two signals, related in frequency, simultaneously on an oscilloscope screen. The oscilloscope must be synchronized with one of the two signals, NOT with the switching rate. If the signal frequencies are not identical, the oscilloscope sweep rate should be selected to operate at a sub-multiple of both signal frequencies.

Example: A is 200 cycles. B is 500 cycles.
Oscilloscope sweep speed of 100 cycles will present 2 cycles of A and 5 cycles of B.
Sync may be obtained from A or B. Use the one that gives the best results.

Interesting observations of this type may be obtained by using input and output signals of a harmonic distortion meter for A and B. More than two inputs can be obtained by using more than one electronic switch.

Two related transients, particularly recurrent phenomena, may be observed. For instance, a flashing light may provide a pair of signals: a signal derived from the closing of the switch and a second signal derived through photocell and amplifier caused by the light itself. The time lag between the two signals may be measured by inserting blanking pulses into oscilloscope trace.

Even low frequency phenomena (DC) signals may be partly observed on an AC-coupled oscilloscope. The Electronic Switch is directly coupled up to the switcher tube and DC inputs will have the same effect as the positioning control. Thus a DC signal will show as an offset in the traces. The operation will not fully equal the DC oscilloscope because the base line (the other trace) will be displaced an equal amount in the opposite direction.

IN CASE OF DIFFICULTY

If difficulties are experienced in the initial testing of the completed instrument, proceed as outlined below:

1. Check the wiring step-by-step. If possible, have a friend check it for you. Even though unskilled, he will frequently spot a mistake consistently overlooked by the constructor.
2. Inspect visually for malfunctioning, such as tubes lighting, discoloring of resistors due to overheating, etc.
3. Inspect electrically with a voltmeter. The nominal voltages between tube socket pins and chassis are tabulated below. These voltages were measured with a vacuum tube voltmeter with 11 megohm input resistance. Lower resistance meters may give lower readings. Normal deviations due to line voltage and component variation may reach ±20%.

TUBE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
6X4 Rectifier	210AC	NC	6.3AC	0	NC	210AC	280		
12AX7 Input	250	0	2.5	6.3AC		250	0	2.5	0
12AU7 Generator	230	NS	180	6.3AC		230	NS	180	0
12AU7 Driver	180	NS	14	6.3AC		180	NS	14	0
12AU7 Switcher	140	2.5	14	6.3AC		140	2.5	14	0
12AX7 Sync. Amp.	100	0	0	6.3AC		100	0	0	0
6C4 Output	250	NC	6.3AC	0	250	140	140		

NS - not significant, as the measurement alters the operation. NC - no connection.

4. Discrepancies of indicated voltages warrant investigation of the particular circuit involved. Wiring errors or faulty components may be found with inspection or resistance measurements.
5. Consider the characteristics of the circuit as outlined in the circuit description. An understanding of the theory will aid in locating and correcting difficulties.

SERVICE

If, after applying the information in this manual and your best efforts, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case Of Difficulty. Possibly it will not be necessary to write.

2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units, and anything else that might help to isolate the cause of trouble.

3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case Of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.

4. Identify the kit Model Number and Series Number, and date of purchase, if available. Also mention the date of the kit assembly manual. (Date at bottom of Page 1.)

5. Print or type your name and address, preferably in two places on the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like it to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was shipped to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be shipped to you, subject to the terms of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed equipment to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a minimal service fee, plus the price of any additional parts or material required. However, if the completed kit is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase, if possible.

Local Service by Authorized HEATHKIT Service Centers is also available in some areas and often will be your fastest, most efficient method of obtaining service. HEATHKIT Service Centers will honor the regular 90 day HEATHKIT Parts Warranty on all kits, whether purchased through a dealer or directly from the Heath Company; however, it will be necessary that you verify the purchase date of your kit.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if the Service Center assists you in locating a defective part (or parts) in your kit, or installs a replacement part for you, you may be charged for this service.

HEATHKIT equipment purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Warranty.

THIS SERVICE POLICY APPLIES ONLY TO COMPLETED EQUIPMENT CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Equipment that has been modified in design will not be accepted for repair. If there is evidence of acid core solder or paste fluxes, the equipment will be returned NOT repaired.

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than the Heath Company.

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally, improper operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information.

A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.

B. Identify the kit Model Number and Series Number.

C. Mention date of purchase.

D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do not dismantle the component in question as this will void the guarantee. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your instrument must be returned for service, these instructions should be carefully followed.

Wrap the equipment in heavy paper, exercising care to prevent damage. Place the wrapped equipment in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the wrapped equipment and the carton. Close and seal the carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the address on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Michigan 49023

ATTACH A LETTER TO THE OUTSIDE OF THE CARTON BEARING YOUR NAME, COMPLETE ADDRESS, DATE OF PURCHASE, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Also, include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by insured parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit if, in HIS OPINION, the article is inadequately packed for shipment.

WARRANTY

Heath Company warrants that all Heathkit parts shall be free of all defects in materials and workmanship under normal use and service, and in fulfillment of such warranty Heath Company will, for a period of three months from the date of shipment, replace any part upon verification that it is defective.

The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

The foregoing warranty is completely void if corrosive solder or fluxes have been used in wiring the equipment. Heath Company will not replace or repair any equipment in which corrosive solder or fluxes have been used.

This warranty applies only to Heath equipment sold and shipped within the continental United States including APO and FPO shipments. Warranty replacement for Heathkit equipment outside the United States is on an f.o.b. factory basis. Contact the Heathkit authorized distributor in your country or write: Heath Company, International Division, Benton Harbor, Michigan, U.S.A.

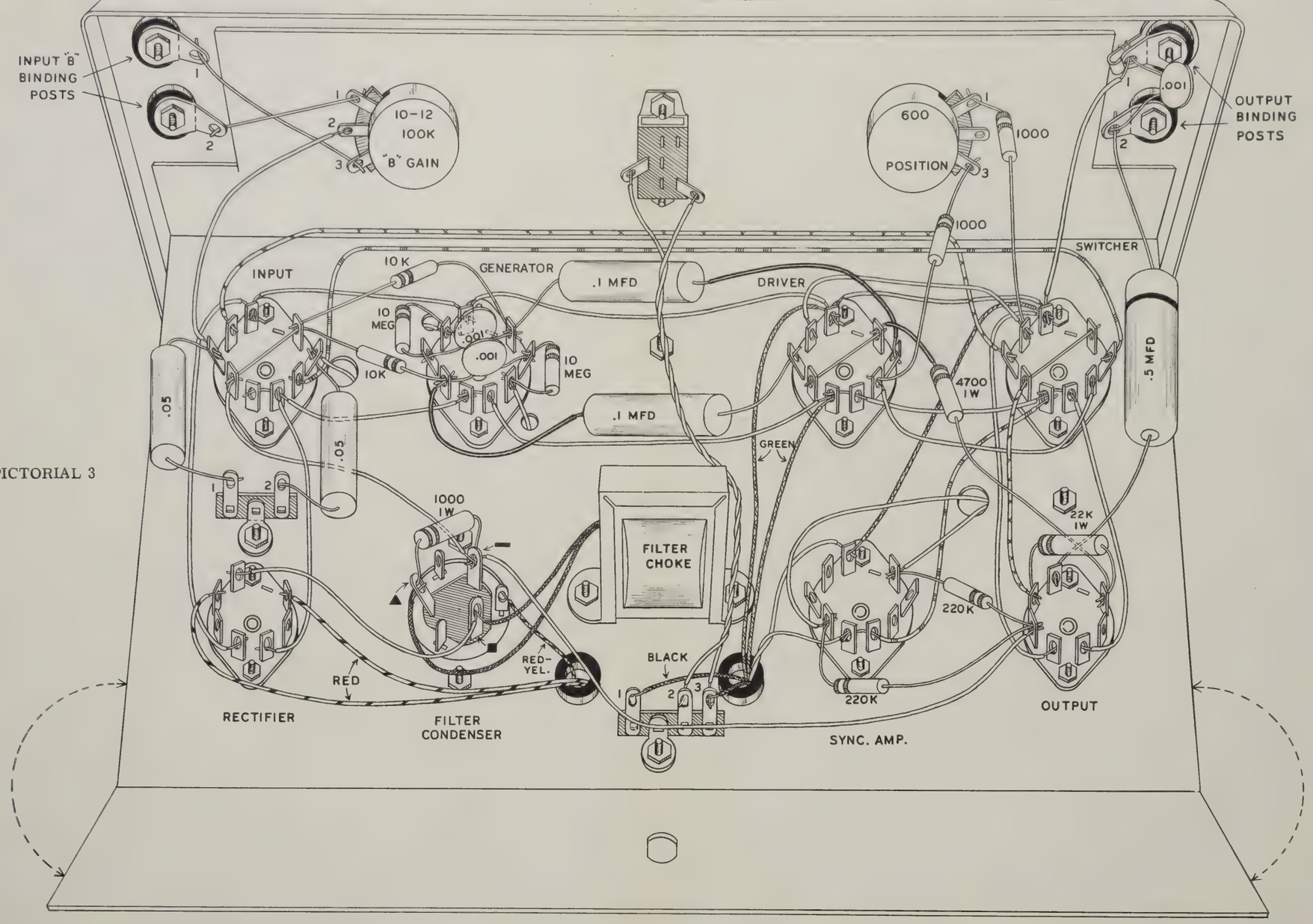
HEATH COMPANY

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-9	2	1000 Ω
1-20	4	10 KΩ
1-25	1	47 KΩ
1-26	2	100 KΩ
1-29	2	220 KΩ
1-40	6	10 megohm
1-2A	1	1000 Ω 1 watt
1-24A	1	4700 Ω 1 watt
1-5A	1	22 KΩ 1 watt
Condensers		
21-14	3	.001 μfd disc
23-2	1	.005 μfd paper
23-8	1	.02 μfd paper
23-59	3	.05 μfd paper
23-28	3	.1 μfd paper
23-56	3	.5 μfd paper
25-9	1	20-20-20 μfd 300 volt elec.
Controls-Switches		
10-34	1	600 Ω control
10-40	1	100 KΩ control 1/4"
10-12	1	100 KΩ control 3/8"
60-1	1	SPST slide switch
63-88	1	4-pos. rotary switch

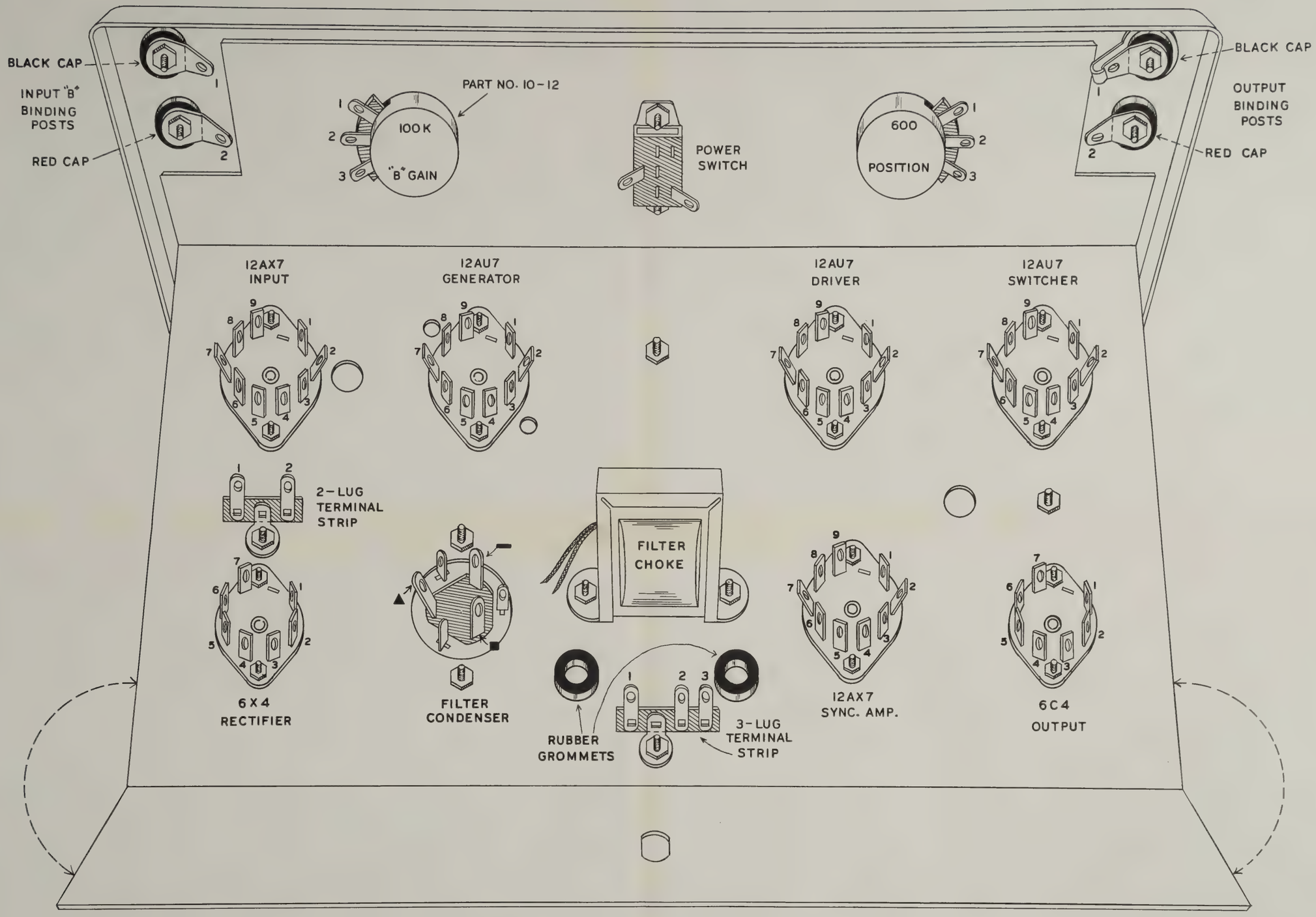
PART No.	PARTS Per Kit	DESCRIPTION
Wire		
89-1	1	Line cord
206-4	1	length Spirashield
340-2	1	length #20 bare wire
340-3	1	length #16 bare wire
344-59	1	length Hookup wire
346-1	1	length Sleeving
346-5	1	length 1/4" sleeving
Sheet Metal Parts		
90-235	1	Cabinet
200-M94	1	Chassis
203-82F797, 798, 799	1	Panel
211-15	1	Handle
Binding Posts-Terminals-Sockets		
100-M16B	3	Binding post cap, black
100-M16R	5	Binding post cap, red
427-2	8	Binding post base
75-17	16	Insulator bushing
431-15	1	1-lug terminal strip
431-2	2	2-lug terminal strip
431-3	1	3-lug terminal strip
434-15	2	7-pin wafer socket
434-16	5	9-pin wafer socket
434-22	1	Pilot light socket

PART No.	PARTS Per Kit	DESCRIPTION
Tubes-Lamp		
411-4	1	6C4 tube
411-25	3	12AU7 tube
411-26	2	12AX7 tube
411-64	1	6X4 tube
412-1	1	#47 pilot lamp
Hardware		
250-2	14	3-48 screw
250-8	2	#6 x 3/8 sheet metal screw
250-9	10	6-32 screw
250-48	4	6-32 x 1/2" screw
250-83	2	#10 x 1/2" sheet metal screw
252-1	14	3-48 nut
252-3	22	6-32 nut
252-7	4	Control nut
253-9	4	#8 flat washer
253-10	4	Control washer
Hardware, Cont'd.		
254-1	14	#6 lockwasher
254-4	4	Control lockwasher
259-1	8	#6 solder lug
259-10	1	Control solder lug
Choke-Transformer-Miscellaneous		
46-3	1	Filter choke
54-34	1	Power transformer
73-1	2	3/8 grommet
75-24	1	Line cord strain relief
261-9	4	Rubber feet
462-187	4	Knob
481-4	1	Condenser mounting wafer
331-6		Solder
595-576	1	Instruction manual

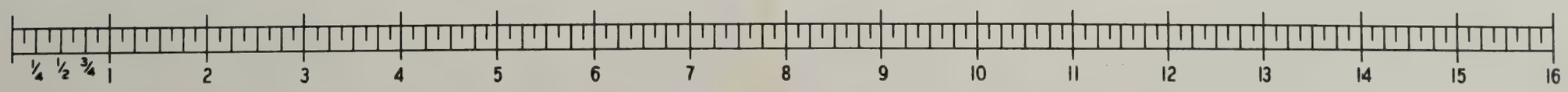


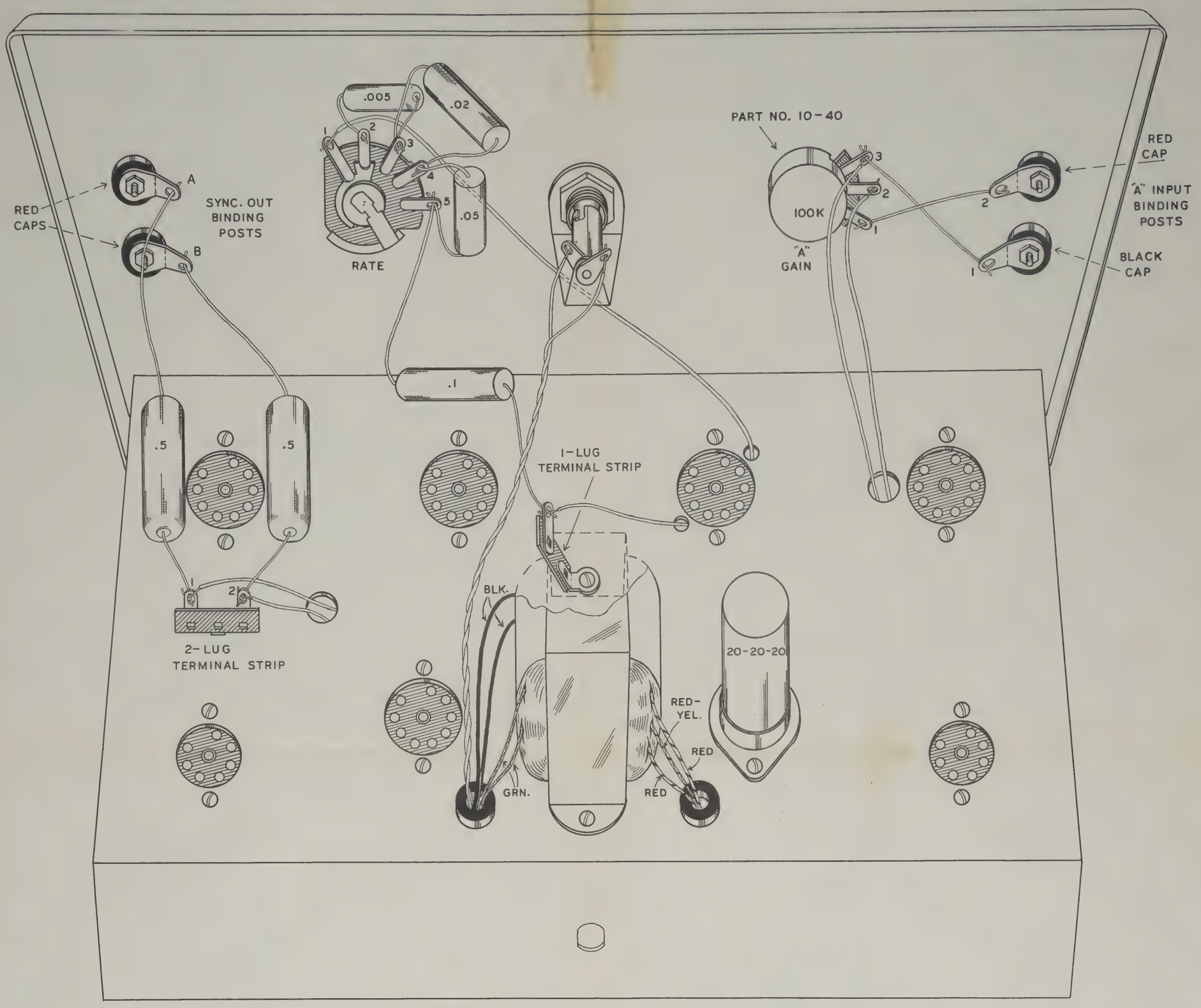
PICTORIAL 3

PICTORIAL 4


BLACK CAP
INPUT "B" BINDING POSTS
RED CAP
1
2
PART NO. 10-12
100K
"B" GAIN
POWER SWITCH
600
POSITION
BLACK CAP
OUTPUT BINDING POSTS
RED CAP
12AX7 INPUT
12AU7 GENERATOR
12AU7 DRIVER
12AU7 SWITCHER
2-LUG TERMINAL STRIP
6X4 RECTIFIER
FILTER CONDENSER
FILTER CHOKE
RUBBER GROMMETS
3-LUG TERMINAL STRIP
12AX7 SYNC. AMP.
6C4 OUTPUT

PICTORIAL 1


¼ ½ ¾ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16



PICTORIAL 2

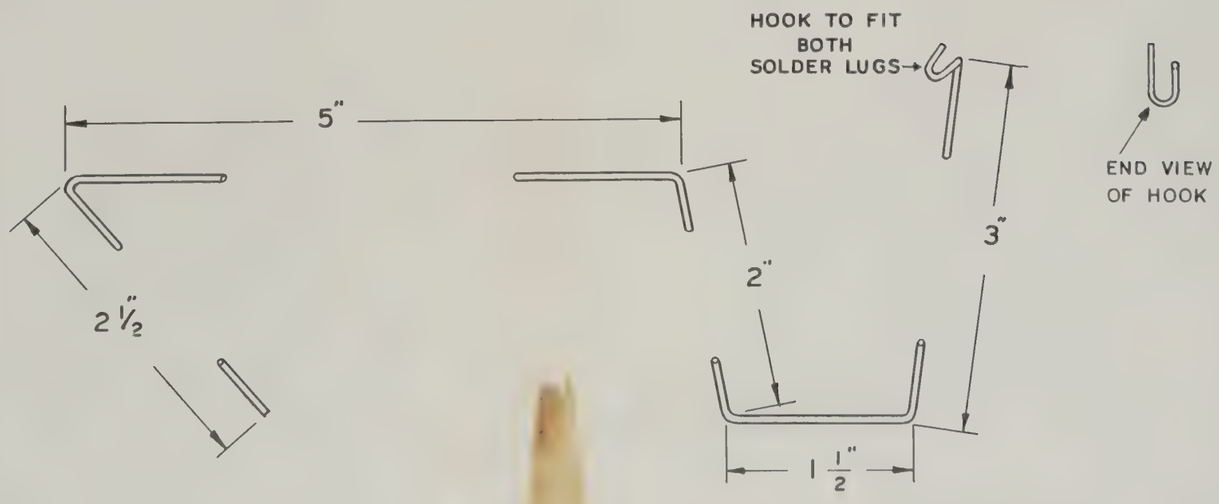
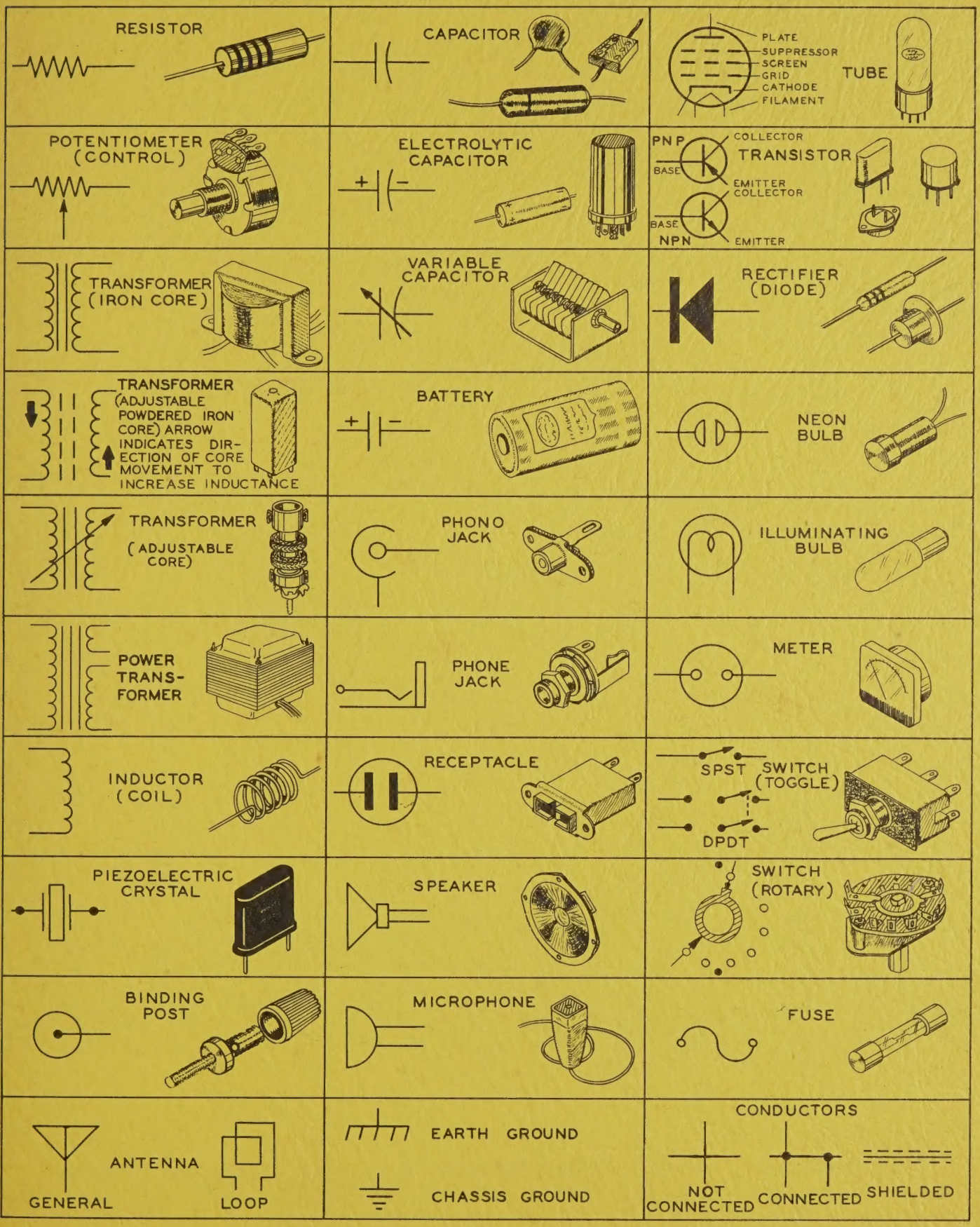


Figure 8

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



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